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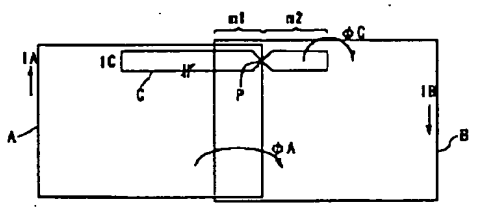
(54) **RF COIL AND MRI DEVICE**

(57) Abstract:

PROBLEM TO BE SOLVED: To display favorable removability, in a multi-element type RF coil, even in the case where the relative positional relationship between coil elements varies every time they are used.

SOLUTION: This coil has a closed loop C disposed near a plurality of coil elements A, B. The coil elements A, B are provided such that their spatial positional relationship is variable. The closed loop C is formed so that magnetic interference between the coil elements A and B may be removed or reduced. Concretely, the arrangement positions and the configurations of the closed loop C are set so as to set off the amount of change of magnetic beams inter linking from one coil element A to the other coil elements B caused by the change of the spatial positional relationship between the coil elements A and B and the amount of change of the magnetic beams interlinking from the one coil element A to the other coil element B through the closed loop C. It is used as a winding type phased-array coil and a QD coil.



DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to RF coil system of assembly structure which has the function to start RF coil system and MRI (magnetic resonance imaging) equipment, and for a coil portion to consist of two or more coil elements especially, and for the space-position relation between two or more of the coil elements at the time of use to be adjustable, and to remove the magnetic interference between coil elements, and the MRI equipment carrying this equipment.
[0002]
[Description of the Prior Art] Magnetic resonance imaging is the technique of reconfigurating a picture from MR signal which excites magnetically the nuclear spin of the analyte placed into the static magnetic field by the RF signal of the RAMOA frequency, and is generated with this excitation.
[0003] In the MRI equipment which performs this IMEJINGU, the element which manages transmission and reception of a RF magnetic field is RF coil. This RF coil is asked for high signal to noise ratio (SNR) in order to treat a feeble signal. In order to respond to this, two or more coil elements are arranged, one RF coil is formed, and there is a many element type RF coil which makes two or more of the coil elements drive simultaneously. This many element type RF coil also has various types.
[0004] One of them is a QD coil which combines two pairs of coil elements which make two RF magnetic fields which intersect perpendicularly, and one [another] is a phased array coil (Phased Array Coil) which puts many coil elements side by side, and is received simultaneously. When it carries these many element type RF coils, there is a problem that interference therefore occurs mainly in magnetic mutual induction between coil elements. Since this magnetic interference causes the picture artifact etc., it needs to remove or suppress this.
[0005] There are various things in the technique of this interference removal or suppression (henceforth interference removal). The 1st interference removal technique is a neutralizing circuit by the capacitor bridge concerning the proposal of T.R.Fox. This circuit bridges between two coil elements on a capacitor bridge, supplies the voltage used as the induced electromotive force generated by mutual induction, and an antiphase on a capacitor bridge, and makes interference offset.
[0006] The technique of making a part of two or more coil elements proposed by the paper of Roemer overlap mutually, and arranging it as the 2nd interference removal technique, is known. The magnetic mutual induction between two coil elements can be made to remove by adjusting suitably this portion made to overlap.
[0007] There is technique using the preamp of a low input impedance proposed by paper with still more nearly another Roemer as the 3rd interference removal technique. This technique is set as the conditions on which the inductance which connects between RF coils to the preamp of a low input impedance, and the output capacitor of RF coil resonate on RAMOA frequency. The current of the RAMOA frequency which flows in RF coil can decrease by this, and the magnetic mutual induction between coil elements can be removed.
[0008]
[Problem(s) to be Solved by the Invention] however, the 1- mentioned above -- there were a problem [like] or un-arranging in the 3rd interference removal technique below
[0009] (1) as the number of the coil elements which form RF coil increases first in the case of the capacitor bridge by the 1st interference removal technique -- wiring -- becoming complicated -- complication and large-sized-izing -- it becomes wiring structure the bottom Since the magnetic flux which the closed loop which went via the capacitor bridge is newly formed, and is simultaneously formed of the high frequency current which flows for a coil element became complicated with the closed loop concerned, thereby, the new interference problem may have been generated.
[0010] (2) Moreover, in the overlap arrangement concerning the 2nd interference removal technique, flexibility was low stopped by arrangement of a coil element and there was un-arranging [that

neither a sensitivity distribution of RF coil nor the arrangement not necessarily optimal for signal to noise ratio could be taken].
[0011] (3) When magnetic interference is not so strong, it is sufficient for the thing using the preamp of a low input impedance which is furthermore the 3rd interference removal technique to use this technique. However, when a strong magnetic interference had arisen like [between near for example, the coil element which adjoined,], the interference removal technique with this preamp did not have an enough removal function, and it was not what can be used only as the technique of complementing other interference removal technique.
[0012] (4) Since it shifted from the optimal adjustment state when RF coil is used in the state where the interference state between coil elements changes, about the this 1st [the] and 2nd interference removal technique further again, there was a problem that the expected interference removal function will fall at the beginning.
[0013] For this reason, whenever it uses it, when this arrangement state changes little by little, taking the arrangement structure which shows a strong interference with the coil element which adjoined, for example, an interference suppression function will deteriorate by the change. This situation is shown below concretely.
[0014] RF coil shown in drawing 14 has the structure which total elements 1-4 of four coils attached in the upper surface and/or the inferior surfaces of tongue of the flexible member B, such as a flexible printed circuit board, overlap arrangement of between the coil elements 1-2, between 2-3, and between 3-4 is carried out with the moderate amount of overlap, and the magnetic interference between those coil elements presupposes that it is fully suppressed. And this RF coil (assembly) is twisted around the surroundings of an analyte, and is used for imaging ** as a phased array coil. That is, echo data are simultaneously collected from a four coil element, and it is high SNR, and is the usage of acquiring the picture of the wide field of view.
[0015] As shown drawing 15, typical use of this RF coil is twisted around the head of an analyte, and is a imaging **** case about a head. The amount of overlap of RF coil is beforehand set up supposing the head of standard size. For this reason, when an analyte head is standard size, the amount of overlap between the coil elements 1-4 located in a start edge [when twisting RF coil] and termination side also turns into a suitable amount, and the magnetic interference between those coil elements is also suppressed certainly. When some interference therefore remains in dispersion in the amount of overlap etc., this interference uses together the preamp of for example, a low input impedance, and is suppressed.
[0016] When twisting this RF coil around small heads, such as a childhood child, and it is rolled in the same amount of overlap as drawing 15 as shown in drawing 16 for example, since the amount of overlap between the coil elements 1-4 does not change, there is no change in the removal ability of the mutual interference of a there. However, a crevice is made according to the size of this head being small between RF coils. That is, between an analyte and RF coils becomes far, receiving sensitivity falls, and Picture SNR also falls. If loss of RF coil is completely zero, although this sensitivity fall will not be produced, in fact, work of such an RF coil is impossible and RF coil surely has loss (noise will be generated if it puts in another way).
[0017] Then, suppose that the moderate crevice (opening) was left and twisted around the head of size smaller than the range which defined this RF coil as a standard as shown in the ** type view of drawing 17 between body surfaces (if RF coil is stuck for a body surface too much, in order that having left the moderate crevice may avoid the problem of common knowledge of SNR curving and falling). In this case, the amount of overlap will change from the amount in the reference condition between the coil element 1 and 4. Although the preamp of a low input impedance is used together, this amplifier does not almost have that it has only prepared auxiliary from the first, and the fall of the removal ability accompanying change of this amount of overlap can be covered. Therefore, the mutual interference between the coil elements 1-4 becomes large, and, in almost all cases, the final picture SNR falls. Moreover, unusual sensitivity nonuniformity is also is observed the coil element 1 and near 4. Although preparing the neutralizing circuit which depends for example, on a capacitor bridge between the coil elements 1-4 is also considered, since an interference state changes whenever it uses this RF coil, it is unreal to adjust the amount of many of a neutralizing circuit corresponding to this change.

[0018] When an analyte head is larger than the reference condition of drawing 15 , shortly, on the contrary, the amounts of overlap between the coil elements 1-4 run short, interference removal ability falls, and this problem actualizes.
[0019] By the way, in order to solve or improve the problem of the interference removal technique of a publication in an above-mentioned (1) term - (3) term, this invention person has proposed the 4th [using the variable-reactance loop] interference removal technique in JP,8-229019,A. In detail, it joins together magnetically in the non-contact state electrically to those coil elements, and consists of the closed loop by the good conductor in RF coil which has an at least two coil element, and enables it to adjust the reactance of this closed loop.
[0020] However, since it shifts from the optimal adjustment state when RF coil is too used in the state where the interference state between coil elements changes, even if it used this 4th interference removal technique, the situation that the expected interference removal function will fall at the beginning has not still improved. Although the method of adjusting a reactance to the degree of this gap can also be taken, this is unreal similarly.
[0021] Even if this invention is the case where the relative physical relationship between coil elements changes whenever it was made in view of the problem of such a conventional many element type RF coil for MRI and uses it, even if it does not adjust the adjustment factor of interference removal ability, it sets it as the purpose to offer the MRI equipment which carried RF coil and this which can demonstrate good removal ability each time.
[0022]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, RF coil concerning this invention It has two or more coil elements which bear one side as it is **** in transmission and reception of a RF signal. While considering as the structure which has arranged the closed loop near two or more of these coil elements and equipping the space-position relation between the element with two or more aforementioned coil elements in the adjustable state It is characterized by forming the aforementioned closed loop so that the magnetic interference between coil elements of the aforementioned plurality may be removed or decreased.
[0023] Suitably, in two or more aforementioned coil elements, while arises with a change space-position-related [between coil elements / aforementioned], and the aforementioned closed loop is setting up the arrangement position and the configuration of the closed loop concerned as the example of concrete composition, as the variation of the magnetic flux interlinked from a coil element to the coil element of another side and the variation of the magnetic flux interlinked from the coil element of one of these to the coil element of aforementioned another side via the aforementioned closed loop are made to offset.
[0024] As for the aforementioned coil element for which the aforementioned closed loop bears offset of the variation of the aforementioned magnetic flux in this case, it is desirable that it is the adjoining two coil element. As an example, two or more aforementioned coil elements are coil elements which form the two coil element pair which accomplishes QD coil. As other examples, two or more aforementioned coil elements are two or more coil elements which form a phased array coil. Furthermore, two or more aforementioned coil elements accomplish the wrap around type which are two or more coil elements which form a phased array coil, and twists around the circumference of the image pck-up part of an analyte, and is arranged as other examples. Furthermore, two or more aforementioned coil elements may be two coil elements by which opposite arrangement was carried out so that the image pck-up part of an analyte might be inserted.
[0025] Two or more aforementioned coil elements are RF coils characterized by overlapping mutually and being arranged still more suitably. In this composition, it is also one feature that the amount of overlap of the aforementioned overlap arrangement has adjustable between [at least one] coils.
[0026] furthermore -- while forming the aforementioned closed loop by the conductor in the composition of the suitable example mentioned above -- the conductor -- what reactive element is inserted on the way, and the reactance of the aforementioned reactive element is set up for so that the absolute value of the comprehensive reactance of this closed loop may become small compared with the state where the reactive element is not inserted in the closed loop concerned is desirable
[0027] In this composition, the aforementioned reactive element is the reactance adjustable type of

element suitably. moreover, for example, the aforementioned closed loop -- the above -- it is the loop object which formed the conductor in the shape of an abbreviation strip of paper, and it is arranged so that it may combine with the two coil element which adjoins mutually magnetically this closed loop becomes opposite [the sense of guidance magnetic flux] in a position in the middle of the loop -- as -- the above -- the configuration which made the conductor cross mutually may be accomplished Moreover, the aforementioned closed loop is the inside of the coil elements which two or more aforementioned coil elements form, may be arranged near [one] the side edge, and may be arranged near the outside of these coil elements.

[0028] Furthermore, in each composition mentioned above, the interference suppression circuit which equipped the outgoing end of two or more aforementioned coil elements with the preamp of a low input impedance may be connected auxiliary.

[0029] On the other hand, this invention can offer the MRI (magnetic resonance imaging) equipment which attains the purpose mentioned above. In MRI equipment equipped with RF coil which bears at least one side of the functions to receive MR signal of the RF which produced the composition in the function to transmit a RF magnetic field signal to an analyte, and its analyte While the aforementioned RF coil is equipped with two or more coil elements and the closed loop arranged near two or more of these coil elements and the space-position relation between the element is equipped with two or more aforementioned coil elements in the adjustable state It is characterized by forming the aforementioned closed loop so that a mutual magnetic interference of two or more aforementioned coil elements may be removed or decreased.

[0030]

[Embodiments of the Invention] Hereafter, the operation gestalt of this invention is explained based on an accompanying drawing.

[0031] The following operation gestalten explain the outline composition and its operation of the MRI (magnetic resonance imaging) equipment used in common to the beginning with reference to drawing 1 .

[0032] This MRI equipment is equipped with the berth section which carries the patient P as an analyte, the static-magnetic-field generating section which generates a static magnetic field, the inclination magnetic field generating section for adding positional information to a static magnetic field, the transceiver section which transmit and receive a RF signal, and the control and operation part which bear control and picture reconstruction of the whole system.

[0033] The static-magnetic-field generating section is a static magnetic field H0 to the shaft orientations (Z shaft orientations) of opening (space for a diagnosis) of the shape of a cylinder in which the magnet 1 of a superconductivity method and this magnet 1 are equipped with the static-magnetic-field power supply 2 which supplies current, and Analyte P is inserted loosely. It is made to generate. In addition, the SIMM coil 14 is formed in this magnet section. The current for static-magnetic-field equalization is supplied to this SIMM coil 14 from the SIMM coil power supply 15 under control of the host computer mentioned later. The berth section can insert in opening of a magnet 1 the top plate which carried Analyte P possible [evacuation].

[0034] The inclination magnetic field generating section is equipped with the gradient coil unit 3 included in the magnet 1. This gradient coil unit 3 is equipped with 3 sets (kind) for generating the inclination magnetic field of X and Y which intersect perpendicularly mutually, and Z shaft orientations of x, y, and the z coils 3x-3z. The inclination magnetic field section equips x, y, and the z coils 3x-3z with the inclination magnetic field power supply 4 which supplies current again. This inclination magnetic field power supply 4 supplies the pulse current for making the basis of the control of a sequencer 5 mentioned later, x, y, and the z coils 3x-3z generate an inclination magnetic field.

[0035] By controlling the pulse current supplied to the inclination magnetic field power supplies 4-xy and the z coils 3x-3z, three shafts X and Y and the inclination magnetic field of a Z direction which are a physical shaft can be compounded, and each logic shaft orientations of the slice direction inclination magnetic field Gs which intersects perpendicularly mutually, the phase encoding direction inclination magnetic field germanium, and the direction (frequency encoding direction) inclination magnetic field Gr of read-out can be set up and changed arbitrarily. Each inclination magnetic field of the slice direction, the phase encoding direction, and the direction of read-out is

superimposed by the static magnetic field H0.
[0036] The transceiver section is equipped with the RF coil 7 arranged near the analyte P in the photography space in a magnet 1, and transmitter 8T and receiver 8R connected to this RF coil 7. As an RF coil, the coil assembly of various modes is chosen and arranged according to the gestalt and the image pck-up purpose of an image pck-up part so that it may mention later.
[0037] Transmitter 8T and receiver 8R operates under the control of a sequencer 5 mentioned later. Transmitter 8T supply RF current pulse of the RAMOA frequency for exciting nuclear magnetic resonance (NMR) to the RF coil 7. After receiver 8R incorporates MR signal (RF signal) which the RF coil 7 received and performs various kinds of signal processing, such as front-end amplification, intermediate frequency conversion, a phase detection, low frequency amplification, and filtering, to this, A/D conversion of it is carried out and it generates the digital variable data (original data) of MR signal.
[0038] Furthermore, control and operation part are equipped with a sequencer (called a sequence controller) 5, a host computer 6, an arithmetic unit 10, the storage unit 11, a drop 12, and the input machine 13. Among this, with the software procedure based on various modes memorized beforehand, a host computer 6 has the function to generalize operation of the whole equipment while ordering a sequencer 5 pulse sequence information.
[0039] A sequencer 5 once inputs the digital data of MR signal which receiver 8R outputted, and it is constituted so that this may be transmitted to an arithmetic unit 10 while having CPU and memory, memorizing the pulse sequence information sent from the host computer 6 and controlling operation of the inclination magnetic field power supply 4, transmitter 8T, and receiver 8R according to this information. Here, pulse sequence information is all information required in order to operate inclination magnetic field power supply 4, transmitter 8T, and receiver 8R according to a series of pulse sequences, for example, the information about the intensity of the pulse current impressed to x, y, and the z coils 3x-3z, impression time, impression timing, etc. is included.
[0040] Moreover, an arithmetic unit 10 inputs the digital data (original data or raw data) which receiver 8R outputted through a sequencer 5, arranges original data to the Fourier space on the internal memory (called k space or a frequency space), gives this original data to the two-dimensional or 3-dimensional Fourier transform for each class, and reconfigurates it to the image data of a real space. moreover, synthetic processing of data concerning [an arithmetic unit] a picture and difference -- it is possible to perform data processing etc.
[0041] not only the image data that the storage unit 11 has memory and was reconfigurated but above-mentioned synthetic processing, and difference -- the image data to which processing was performed can be kept A drop 12 displays a picture. moreover, the photography conditions for which a way person wishes through the input machine 13, a pulse sequence, picture composition, and difference -- the information about an operation can be inputted into a host computer 6
[0042] (1st operation gestalt) The 1st operation gestalt of the RF coil 7 carried in the MRI equipment mentioned above is explained with reference to drawing 2 - drawing 6 .
[0043] The RF coil 7 concerning this operation gestalt is a coil assembly which constitutes one gestalt of a many element type RF coil, and is formed in the phased array coil usable as a wrap around (wraparound) type used twisting around a head etc. A general view of this RF coil 7 is typically shown in drawing 2 . it is shown in this drawing -- as -- the upper surface and/or the inferior surface of tongue of the flexible substrate 21 -- the four coil elements 1-4 -- the shape of an array -- and in the electric non-contact state, it is made to overlap mutually and the part is arranged In drawing 2 , it is only that the lap condition of a coil element etc. shows an example, and illustration of the path of the outgoing end taken out through the output capacitor from each coil element is omitted.
[0044] This amount of overlap can leave and loop around a moderate crevice (opening with a body surface) the analyte part (for example, head) beforehand defined as standard size when the RF coil 7 was twisted, and most magnetic interference between each element of the coil elements 1-4 is set up so that it may become zero.
[0045] When this RF coil 7 is opened to a plane, in the field of the coil element 1 by the side of the end of this RF coil, the closed loop 22 is arranged in the non-contact state electrically [the element 1 concerned]. as the electric good conductor 23 forms an abbreviation rectangle, while a time is

wound and carried out and a closed loop 22 forms -- the predetermined position of the path -- the circumference -- the intersection P which replaced the position of a conductor mutually in the electric non-contact state is formed The electrostatic-capacity adjustable variable capacitor 24 is inserted in the middle of the path of a conductor 23 again.

[0046] A closed loop 22 is arranged along with one side edge section within the coil side which coil elements make. Moreover, this closed loop 22 is arranged in the state where the remaining loop side was made to jump out of the coil element 1 while it locates one loop side of the intersection P in the coil side which the aforementioned coil element 1 makes. For this reason, when this RF coil 7 is twisted around the circumference of image pck-up parts, such as a head, the loop side field of which the closed loop 22 jumped out will be located along with one ****** of the coil side which the coil element 4 of an opposite side makes.

[0047] Here, operation of this RF coil 7 is explained focusing on the viewpoint of the mutual-interference removal ability in connection with this invention.

[0048] Paying attention to the coil elements 1 and 4 which are equivalent to the arrangement position of a closed loop 22 among the four coil elements 1-4 which accomplish now the RF coil 7 mentioned above (coil element in the state where RF coil was twisted), these coil elements 1 and 4 are expressed as A and B for convenience, and a closed loop 22 is expressed as C for convenience, and it explains based on drawing 3 -6.

[0049] There are two coil elements A and B mostly aligned with the RF frequency of the same value. These coil elements A and B presuppose that it interferes each other magnetically by mutual induction. That is, a part of magnetic flux which the current which flows for one coil element A makes has interlinked for the coil element B of another side. This amount of interlinkage is set to phiA.

[0050] When this amount of magnetic-flux interlinkage phiA is in the interference state which is not zero, the current IA which flows for one coil element A guides Current IB to the coil element B of another side by electromagnetic induction. This is a mutual interference. Although drawing 3 is indicated in this direction, the direction changes Current IA and IB by with what impedance the output of the coil element B is undergone, and the factor. Usually the impedance involving the coil element B has a resisted part more dominant than a reactance. For this reason, as for Current IB, it is usual that the phase has shifted 90 degrees to IA. However, in the following explanation, it concentrates on compensating the magnetic flux to interlink. If this compensation can be performed, Current IB will be in the state which removed zero, i.e., a mutual interference.

[0051] With this RF coil 7, closed-loop C (closed loop 22) is put side by side for the two coil elements A and B (coil elements 1 and 4) of overlap arrangement mentioned above at the time of coil use. By the intermediate intersection P, the position of a conductor interchanged mutually and has reversed this closed-loop C. In this intersection P, a conductor crosses with predetermined path clearance mutually, and is in a non-contact state. This closed-loop C has the magnetic coupling by mutual induction between one coil elements A, and magnetic coupling is in it also about between another coil elements B. Since this closed-loop C is formed with the good conductor, the impedance to the RF signal of a closed loop has an inductance more dominant than a resisted part.

[0052] Moreover, the electrostatic-capacity adjustable capacitor is inserted in the middle of this closed-loop C at the closed loop and the serial. The part is interlinked also to closed-loop C among the RF magnetic fields which the current IA which flows for one of the two's coil element A makes. The magnetic flux interlinked to this closed-loop C generates induced electromotive force in a closed loop, consequently Current IC flows in a closed loop. As for this current IC, the phase and size are determined by the impedance of closed-loop C. This current IC builds a RF magnetic field further, interlinks a part of this RF magnetic field for the coil element B of another side, and sets the amount to phiC.

[0053] In drawing 3 , since the coil elements A and B overlap only the proper amount mutual exactly, the current IA of one coil element A does not carry out induction of the current IB to the coil element B of another side, but is in a non-interfering state. That is, amount of flux linkages phiA is about 0. Although the current IA of the coil element A carries out induction of the current IC of closed-loop C at this time, the loop sides m1 and m2 reversal before of closed-loop C centering on Intersection P and after reversal are included mostly equivalent [every] in the coil side which the

coil element B makes. Therefore, amount of flux linkages phiC is about 0, and the non-interfering state between the coil elements A and B is not disturbed by existence of closed-loop C.
[0054] In both drawing 4 , since both coil elements A and B overlap too much, only with this overlap arrangement structure, a non-interfering state will not be able to be maintained but the current IA of one coil element A will carry out induction of the current IB to the coil element B of another side. That is, it interferes and amount of flux linkages phiA is a positive value.
[0055] Simultaneously, the current IA of this coil element A carries out induction of the current IC to closed-loop C. Since the capacitor 24 is adjusted to closed-loop C, the synthetic reactance of closed-loop C is made also to positive also negative, and the size can also be controlled by adjusting the electrostatic capacity. The electrostatic capacity of this capacitor 24 presupposes that it is adjusted to the comparatively big value. In this case, the synthetic reactance of closed-loop C is positive, i.e., it is inductive. Thereby, the phase of the current IC by which induction is carried out to closed-loop C turns into an antiphase in the current IA of the coil element A.
[0056] For this reason, in drawing 4 , the magnetic flux which closed-loop C makes gives the interference from [from Intersection P] the magnetic flux which the coil element A makes from a left-hand side loop portion, and a retrose A, i.e., a coil element, and interference of an opposite direction to the coil element B. In a right-hand side loop portion, the magnetic flux of left-hand side and the reverse sense is given to the coil element B from Intersection P. The size of Current IC can be set up by electrostatic-capacity adjustment of a capacitor more greatly enough than the size of Current IA. Since the inductance of closed-loop C is considerably offset by the direction of Current IC by the capacitor 24 to this being based on the impedance of the preamplifier by which the direction of Current IA is connected to the coil element A etc., and current being suppressed low, the total reactance is fairly based on a bird clapper small. For this reason, comparatively [with the small size], closed-loop C can supply a lot of magnetic flux at the coil element B.
[0057] Therefore, when it sees as amount of magnetic flux phiC which closed-loop C gives to the coil element B in the case of the coil arrangement state of drawing 6 being total, the coil element A is set to amount of magnetic flux phiA given to the coil element B to an antiphase. And since the size of amount of magnetic flux phiC can be adjusted by adjusting the electrostatic capacity of a capacitor 24, the state where it is set to phiC=-phiA is acquired after all. Even when considering as how which the interference accompanying the excess of overlap produces among the coil elements A and B by this, it is denied by the magnetic flux to which induction of the magnetic flux from the coil element A which has caused the interference is carried out via closed-loop C, and this mutual interference is suppressed to level without removal or a problem.
[0058] The coil arrangement state of drawing 5 is in the state where the amount of overlap between the two coil elements A and B is insufficient, conversely. Considering the sense which magnetic flux interlinks, amount of flux linkages phiA from the coil element A becomes a phase contrary to the state of drawing 4 . And in drawing 5 , the magnetic flux which the loop portion on the right-hand side of Intersection P makes becomes dominant, and amount of flux linkages phiC from closed-loop C works in the direction which offsets amount of flux linkages phiA too. Therefore, it works so that the flux linkage from closed-loop C may negate the flux linkage from the coil element A, and this mutual interference can be removed or reduced.
[0059] In this case, when the electrostatic capacity of a capacitor 24 is the value used by interference removal of drawing 4 , it is decided by the detailed configuration of closed-loop C, and detailed physical relationship with the coil elements A and B whether fulfill the conditions of phiC=-phiA again. For this reason, those factors are set up so that a magnetic field distribution may be calculated and it may become the optimal configuration and optimal arrangement. However, even if this factor setup is rough, a remarkable grade and interference can be suppressed. In this case, if an interference removal means with the preamp 15 of a low input impedance mentioned above is used together as shown in drawing 6 , even if it can remove a mutual interference mostly and complicates neither the geometry of a coil, nor the design of a configuration recklessly, the outstanding interference removal ability is securable.
[0060] Since especially generating of the interference accompanying the space-position change between the coil elements 1-4 of ends became a problem on the occasion of the use, although it explained as an example which removes this, this RF coil 7 should just arrange a closed loop

equivalent to what was mentioned above between applicable elements, when interference cannot be removed only by overlap arrangement among other coil elements.
[0061] As mentioned above, if the RF coil 7 shown in drawing 2 is used, the magnetic mutual interference between the coil elements 1-4 of the ends at the time of use can be practically reduced to removal or the level which hardly poses a problem, generating of the picture artifact can be removed or suppressed, and good quality of image can be secured.
[0062] When using it especially, twisting this RF coil 7 for example, around a patient head, as shown in drawing 15 mentioned above - drawing 17 , when head sizes differ, the space-position relation between coil elements may shift from the range decided as a standard. However, the mutual· interference between coil elements can be removed or suppressed exactly, without adjusting in any way at the place of IMEJINGU, such even case.
[0063] Furthermore, the wiring structure which became complicated, and complication and the wiring structure which turned on a large scale are avoidable like [in the case of the capacitor bridge by the 1st conventional interference removal technique]. The closed loop which went via the capacitor bridge is newly formed simultaneously, and it has not been said that this will generate a new interference problem.
[0064] Furthermore, unlike the case of the overlap arrangement concerning the 2nd conventional interference removal technique, the flexibility of arrangement of a coil element can also fully be secured and can take the optimal arrangement from a viewpoint of a sensitivity distribution of RF coil or signal to noise ratio.
[0065] The preamp of a low input impedance which is the 3rd conventional interference removal technique can be effectively used as auxiliary means further again.
[0066] (2nd operation form) RF coil concerning the 2nd operation form is explained with reference to drawing 7 - drawing 9 .
[0067] This RF coil changes the arrangement position of a closed loop in the 1st operation form mentioned above. The principle view of drawing 7 - drawing 9 is met, and this is explained (the reference mark of these drawings is made in agreement with the sign in drawing 3 - drawing 5).
[0068] since the induced current IC by which induction is carried out to closed-loop C presents a to some extent big value -- concentration of a sensitivity distribution near the closed loop -- or disorder of a sensitivity distribution produces a neutral zone etc. conversely This disorder becomes picture unevenness. Therefore, it is important for closed-loop C from the interested part of an image pck-up to arrange from a long distance, however the coil elements A and B to near if possible.
[0069] From this viewpoint, desirably, as shown in drawing 7 - drawing 9 , closed-loop C is the outside of the coil side which each of the two coil elements A and B makes, and is put on the near.
[0070] It is in the state which Current IB is zero and has not interfered in the coil elements A and B mutually according to an overlap state with proper drawing 7 . Since the loop portion reversal before of closed-loop C and after reversal is mostly located along near the surface of the equivalent [every] coil element B, existence of closed-loop C is neutrality mostly about interference, and the hands-off state between the coil elements A and B is not disturbed.
[0071] Drawing 8 shows the state of the excess of overlap between the coil elements A and B. In this case, if closed-loop C does not exist, a strong magnetic interference is among the coil elements A and B. Flux-linkage phiA is a positive value. The current IA of the coil element A carries out induction of the IC. The variable capacitance of closed-loop C is set up so that the total reactance may be positive. That is, suppose that it is inductive.
[0072] In this case, considering the sense of the magnetic flux interlinked from the coil element A to closed-loop C, Current IC is an inphase (it turns to the same direction) IA and shortly. And it is reversed again and the magnetic flux which closed-loop C makes is interlinked for the coil element B. For this reason, the magnetic flux which closed-loop C makes gives the interference from the magnetic flux which the coil element A makes from Intersection P on the left-hand side, and a retrose A, i.e., a coil element, and interference of an opposite direction to the coil element B. On the right-hand side, magnetic flux opposite to left-hand side is supplied to the coil element B from Intersection P. That is, magnetic flux is transmitted from closed-loop C to the coil element B in the magnetic flux and the same direction which are interlinked from the coil element A to the coil element B. In the state of drawing 8 , if magnetic-flux phiC which closed-loop C gives to the coil

element B is total and is seen, it will be set to magnetic-flux phiA which closed-loop A gives to the coil element B to an antiphase. The state where it is exactly set to phiC=-phiA is acquired by adjustment of a capacitor, and interference is removed or suppressed.
[0073] Drawing 9 is a case with few amounts of overlap between the coil elements A and B, and when it is ****, interference between both is removed or suppressed with the same meaning.
[0074] Therefore, since the closed loop has been arranged near the outside of a coil element array also with RF coil concerning this 2nd operation form in addition to the operation effect the same as that of the time of the 1st operation form or equivalent being acquired, disorder of the sensitivity distribution within a coil side can be eliminated, and generating of picture unevenness can be suppressed or prevented.
[0075] (3rd operation form) RF coil concerning the 3rd operation form is explained with reference to drawing 10 - drawing 12 .
[0076] This RF coil changes the configuration of a closed loop in the 1st operation form mentioned above. The principle view of drawing 10 - drawing 12 is met, and this is explained (the reference mark of these drawings is made in agreement with the sign in drawing 3 - drawing 5).
[0077] Closed-loop C concerning this operation form is formed by the straight loop, without making the loop path cross, and is characterized by this attaining the purpose of this invention.
[0078] In drawing 10 , the two coil elements A and B are overlapped a little more deeply than the thing of the composition of drawing 3 or drawing 7 mentioned above. For this reason, if the closed coil C is not formed, it interferes in the coil elements A and B mutually. The closed coil C is adjusting the capacity of the capacitor 24 suitably, and has made the total reactance positive, i.e., inductive.
[0079] Since closed-loop C enters into the coil elements A and B deeply and is arranged, IA of the current IC on the closed coil C guided by Current IA is a retrose. In drawing 10 , when the closed coil C compares the portion n1 on the left of the coil left part of the coil element B with the right-hand side portion n2, its right-hand side portion n2 is larger. For this reason, magnetic-flux phiA which interlinks magnetic-flux phiC with which the magnetic flux generated as the origin interlinks Current IC to the coil element B from the coil element A to the coil element B is a retrose. For this reason, the conditions of phiC=-phiA can be set up and, thereby, interference is eliminated by the position and configuration of capacitor adjustment or closed-loop C among the coil elements A and B.
[0080] Since the coil elements A and B have entered deeply mutually rather than the case of drawing 10 in coil arrangement of drawing 11 , the magnetic flux interlinked from the coil element A to the coil element B increases. However, since the magnetic flux of an opposite direction interlinked from closed-loop C to the coil element B has also entered still more deeply to closed-loop C, the coil element's B increases. Therefore, in general, the conditions of phiC=-phiA are satisfied and the state where there is no almost interference is maintained.
[0081] About the coil arrangement which is insufficient of the overlap of drawing 12 , similarly, in general, the conditions of phiC=-phiA are satisfied and the state near non-intervention or this is maintained.
[0082] In drawing 11 and drawing 12 , it is concerned with optimization of the configuration of closed-loop C how much condition phiC=-phiA of interference removal is materialized in accuracy, and how much whether interference removal can be carried out at fitness. According to this optimization, a closed-loop C configuration may be not a simple rectangle but a configuration distorted somewhat.
[0083] In addition, like the time of the 2nd operation gestalt which mentioned closed-loop C above in coil arrangement of RF coil given in drawing 10 mentioned above - drawing 12 , it is the outside of a coil array and you may arrange to the near.
[0084] (4th operation gestalt) RF coil concerning the 4th operation gestalt is explained with reference to drawing 15 .
[0085] Unlike the thing of each operation gestalt which mentioned this RF coil above, two or more coil elements are related with the structure which is not overlapped. Thus, RF coil which carries out this invention does not necessarily need to take overlap arrangement structure. The principle view of drawing 13 is met and this is explained (the reference mark of these drawings is made in agreement

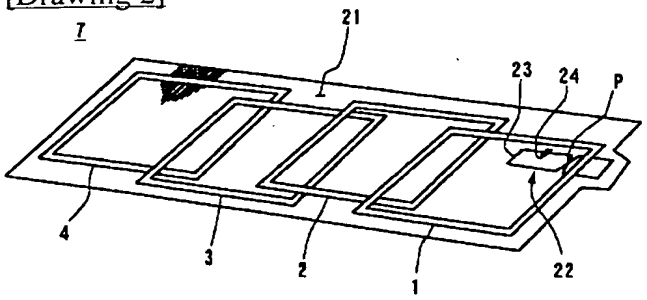
with the sign in drawing 3 - drawing 5).
[0086] The RF coil 7 applied to drawing 13 in an arm or a knee at a kind of a volume coil suitable at the time of imaging **** is shown. This RF coil 7 can be equipped with the two coil elements A and B which countered mutually and have been arranged, and can double them with part size by changing the opposite interval D, and can adjust imaging sensitivity etc. Although a mutual-interference state changes with these adjustments, this invention is applicable also to such coil arrangement composition. Closed-loop C is magnetically arranged possible [combination] through this loop like illustration in the coil elements A and B which counter.
[0087] Suppose that the total reactance of closed-loop C is set as negative (capacitive), i.e., KYAPASHITIBU, in coil arrangement of drawing 15 . In the upper part of closed-loop C, induction of the current IC is carried out in the same direction as the current of the upper coil element A. By the loop of the lower part of closed-loop C, the current IC flows to an opposite direction. The distance D between the coil elements A and B and it are interlocked with, and the distance d between the coil element B and the lower part of the closed coil C has adjustable structure.
[0088] On the whole at the moment of flowing towards illustration, the current IA of the coil element A interlinks the magnetic flux which the coil element A makes for the coil element B toward the bottom of the upper shell of a drawing (F1 reference among drawing). On the other hand, on the whole, the magnetic flux which the lower part of closed-loop C makes is interlinked with the coil element B toward the lower shell top of a drawing (F2 reference among drawing). That is, it is the direction which offsets the interference from the coil element A. if Distance D and d increases, and it decreases or, the magnetic flux which one side will be coil element A involved by while, and is interlinked for the coil element B will decrease (or it increases) Although an offset grade changes, that it is the direction to offset does not change this direction relation. Even if Distance D and d changes, an offset grade comes out enough and, for that, should just optimize the configuration and position of closed-loop C. The capacitor which adjusts the total reactance of closed-loop C by optimizing this may not necessarily be adjustable, and can also be lost. However, in an actual design, the adjustment by the variable capacitor is still useful.
[0089] The following deformation is possible also about this operation gestalt. What is necessary is to make it cross, as the path of closed-loop C goes downward from a top in order to return the sense of lower current, since the current IC of closed-loop C is reversed, in order to use it, the total reactance of closed-loop C being positive, and making, and just to reverse the current of the lower part of the closed-loop C concerned. Even if it installs closed-loop C in the loop outside of the coil elements A and B, it can be made to function similarly by such intersection structure and a reactance polarity adjustment means.
[0090] In addition, in each operation gestalt mentioned above and its modification, it may replace with the capacitor inserted in this loop in series as a means to change the reactance value of closed-loop C, and you may be other circuit element. What is necessary is just the circuit element which can change the reactance of this closed loop in advance. Moreover, it is not necessary to necessarily establish a reactance adjustment means by which the reactance of this loop was adjusted and mentioned above by designing appropriately arrangement of this closed-loop C, a configuration, and/or a size depending on the case.
[0091] Moreover, RF coil which can carry out coil composition of this invention may be a QD (rectangular cross) coil mentioned above.
[0092] this invention can deform suitably in the range which does not deviate from the summary of invention given in a claim, without being limited to the thing of the operation gestalt mentioned above.
[0093]
[Effect of the Invention] As explained above, while the space-position relation between the element is equipped with two or more coil elements in the adjustable state in this invention Since RF coil which formed the closed loop so that the magnetic interference of two or more between coil elements might be removed or decreased, and the MRI equipment carrying this RF coil were constituted By giving a proper reactance to a closed loop, even when the amount of overlap between some [at least] elements between two or more coil elements changes or opposite distance changes, and arranging in a proper position The flux linkage which goes via this closed loop can negate or reduce

the magnetic flux interlinked at an interference place from an interfering agency. Therefore, even if it is the case where the relative physical relationship between coil elements changes whenever it uses it, even if it does not adjust the adjustment factor of interference removal ability, good removal ability can be demonstrated each time.

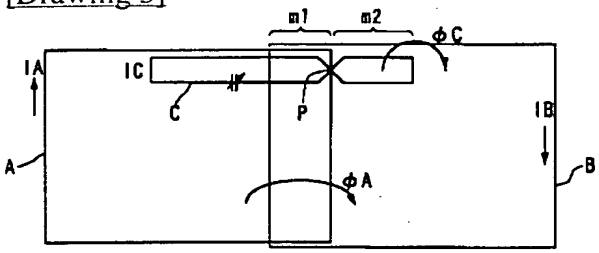
[0094] Thereby, specifically, the phased array coil which can secure the greatest SNR for every analyte can be offered, and quality of image can be raised. Moreover, the degree of use can be provided with RF coil assembly which can change arrangement in the predetermined range and which consists of two or more coil elements, and the mutual interference between coil elements can be certainly removed or reduced also in that case to it. Whenever it arranges RF coil at this time, since the adjustment for SNR reservation is unnecessary, for an operator, image pck-up preparation is easy for it, and it is user-friendly, and its efficiency of the also improves. Furthermore, since it is comparatively simple interference removal composition even if it sees leading about of wiring etc., large-sized-ization of the composition of RF coil and MRI equipment can also be prevented, and high reliability can be secured.

DRAWINGS

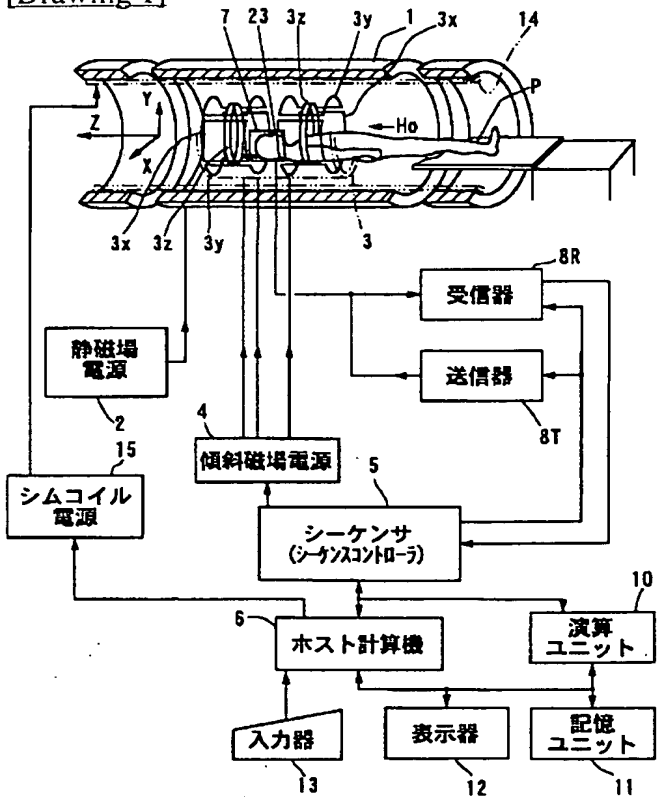
[Drawing 2]



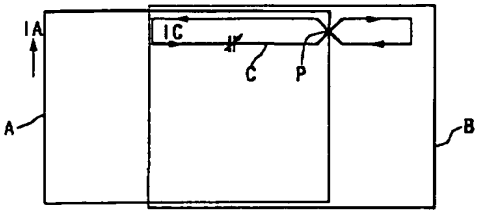
[Drawing 3]



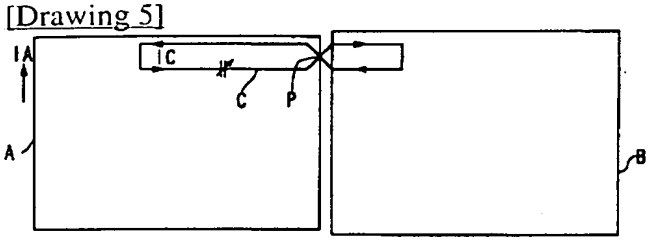
[Drawing 1]



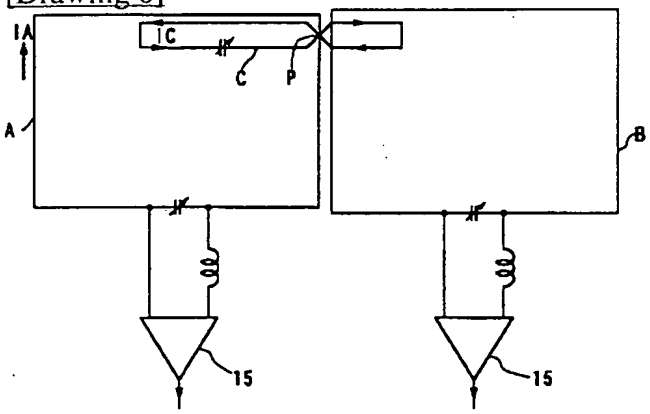
[Drawing 4]



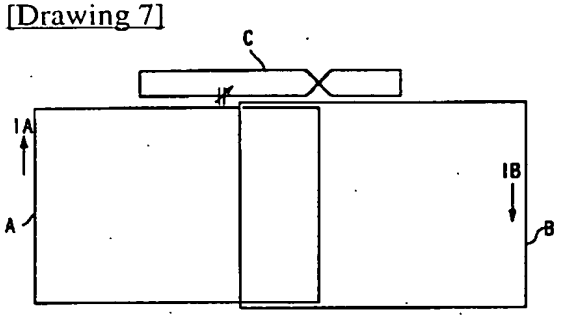
[Drawing 5]



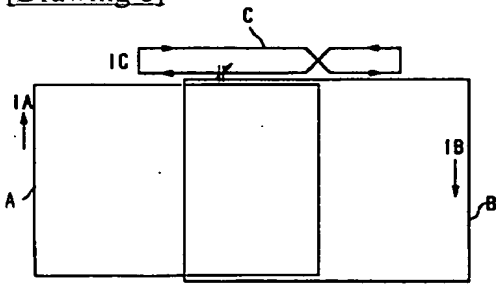
[Drawing 6]



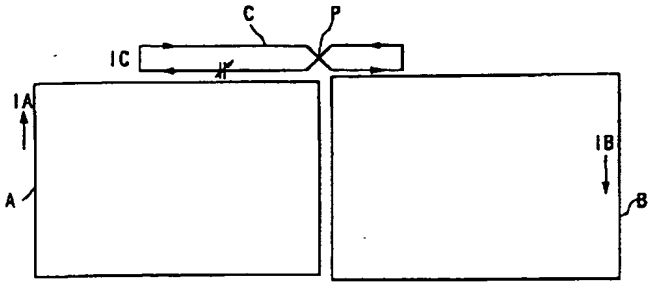
[Drawing 7]



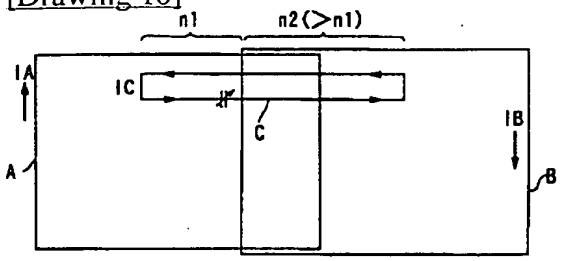
[Drawing 8]



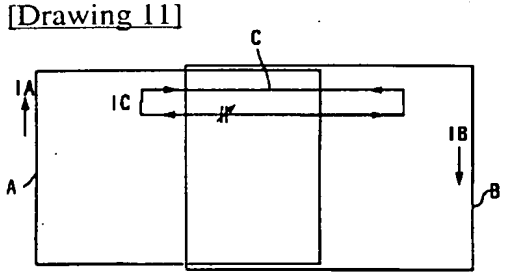
[Drawing 9]



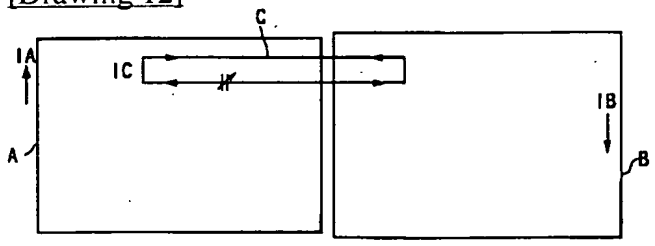
[Drawing 10]



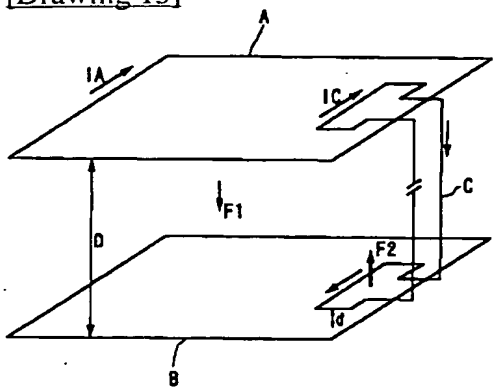
[Drawing 11]



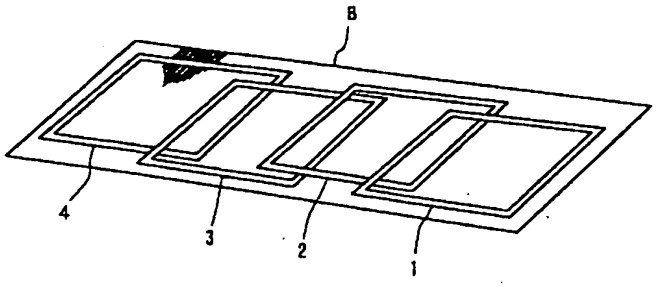
[Drawing 12]



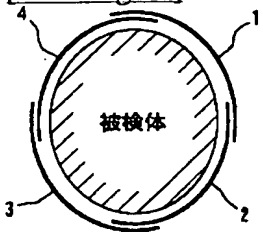
[Drawing 13]



[Drawing 14]



[Drawing 15]



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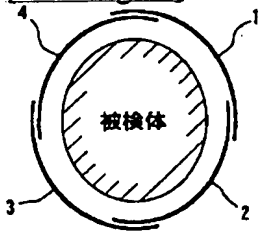
[Drawing 16]



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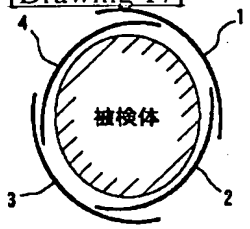
[Drawing 17]



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